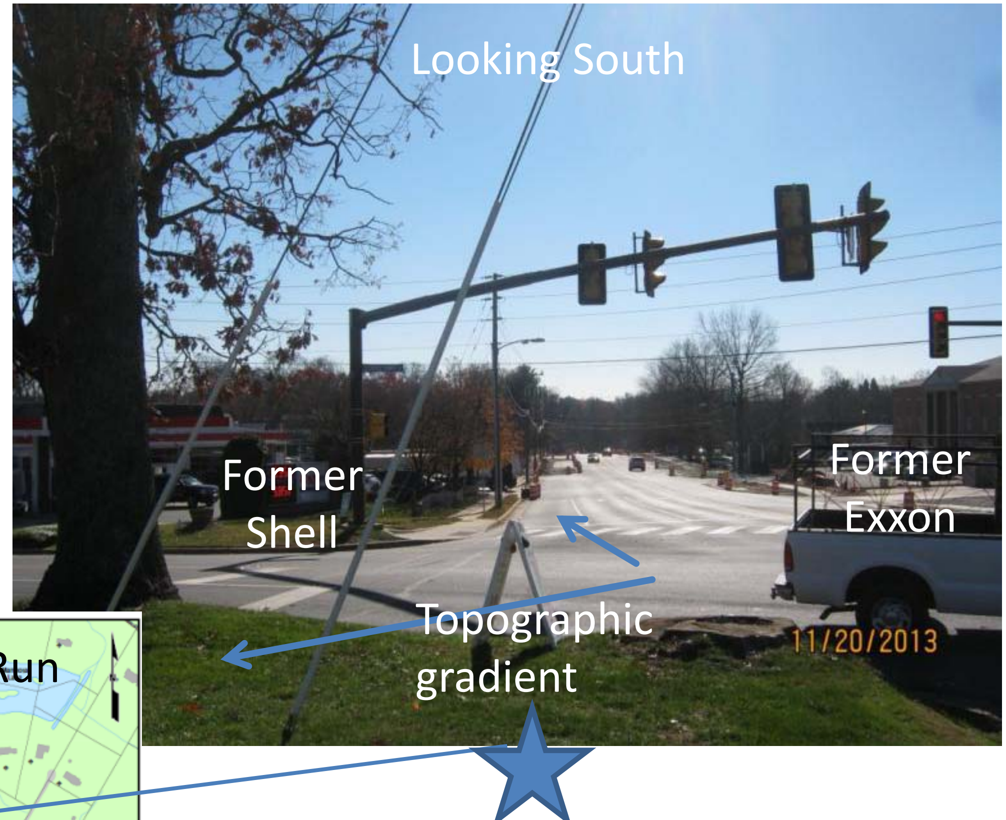
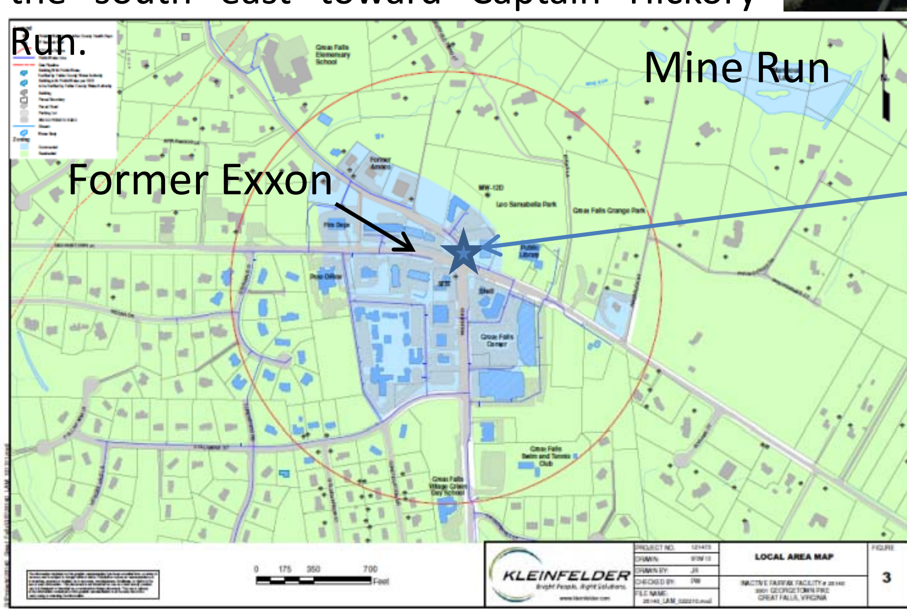
Site Setting

The Site is in a commercial area. The Great Falls shopping center and Former Shell (new Exxon) gasoline station are to the east, the Village Centre shopping center is to the west and south and office buildings are to the north. The nearest residential properties with private supply wells are approximately 1000 feet to the north. The Site is currently vacant, but plans exist to develop the property as a retail bank. The topography of the area slopes to the north and north-east toward Mine Run and to the south east toward Captain Hickory Run.

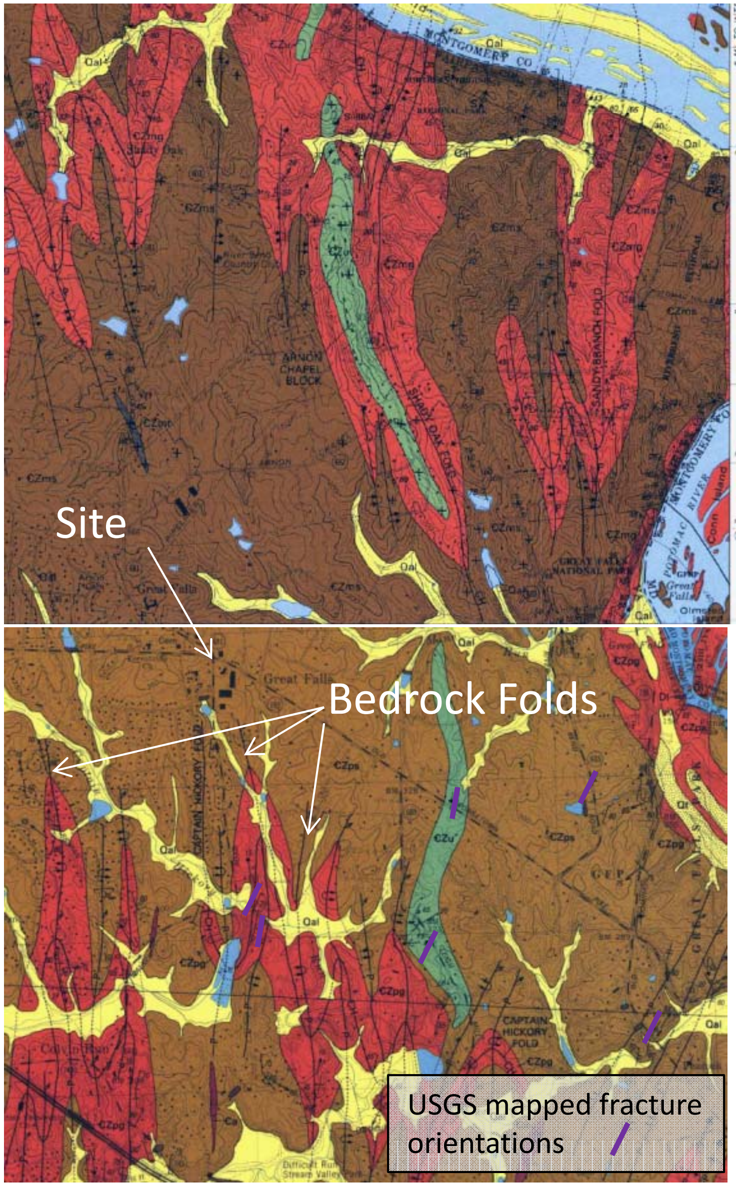




Kleinfelder 2013

Geology

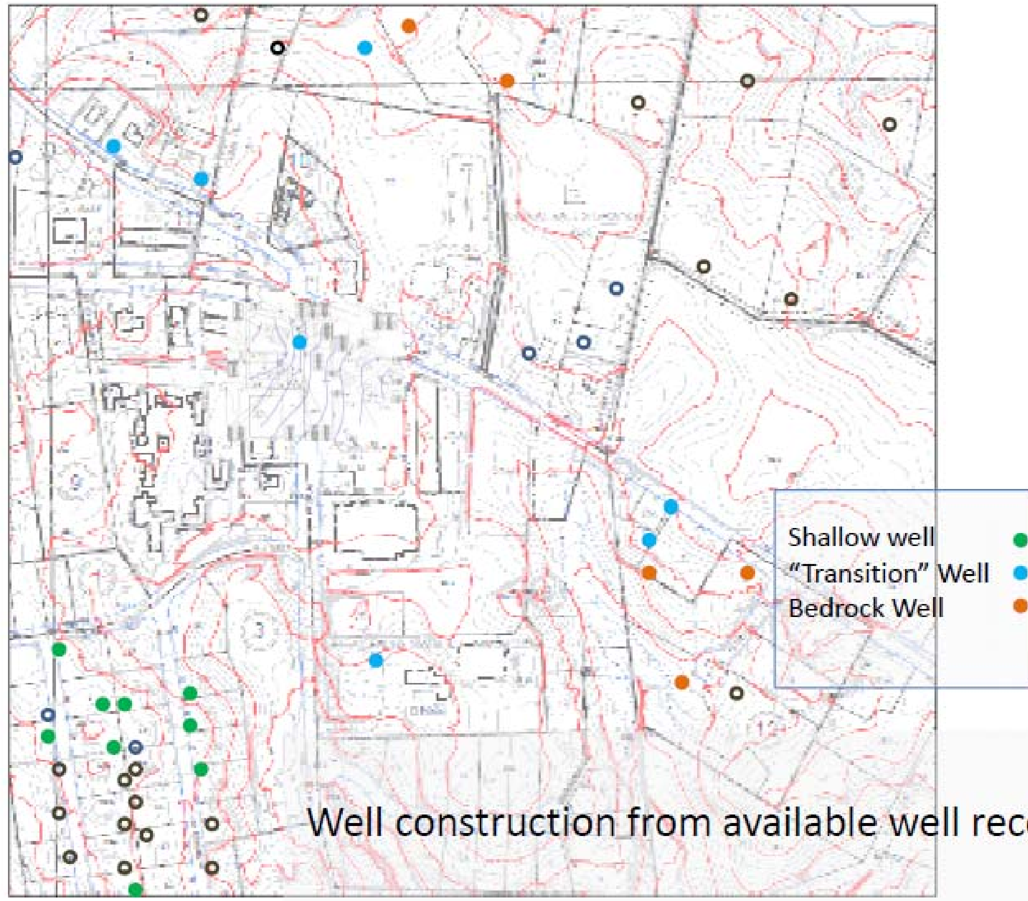
Groundwater is typically 30 to 40 feet deep in highly weathered rock known as "saprolite" (typically stiff reddish brown clays and sandy silts). The saprolite becomes progressively less weathered with depth ("the transition zone"). Below the saprolite and transition zone is the unweathered Peters Creek Schist. This zone could be as shallow as 40 feet or as deep as 100.



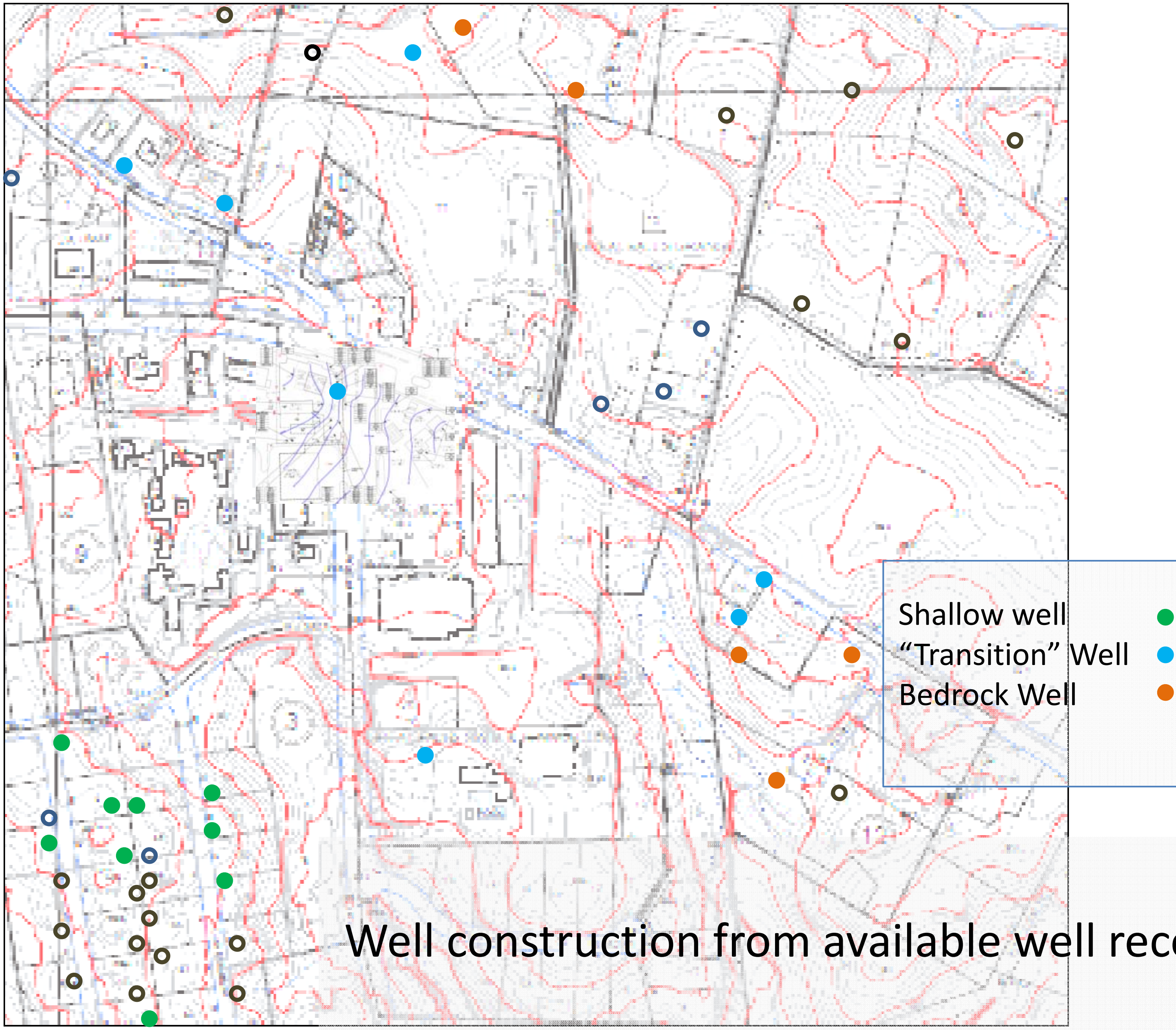
USGS Seneca and Vienna Sheets

Great Falls Wells

- Shallow bored wells 30 to 70 feet “tapping” saprolite and transition zone: high storage, but susceptible to local surface pollution and drought (older wells, pre 1970s). Shallow casing.
- Deeper wells in transition zone and bedrock (70 to 200 feet dep). Casing typically to bottom of saprolite (1970s and later). Often good storage and recharge.
- Bedrock wells: low storage, need to be deep to provide adequate supply, prone to high iron and manganese (300-1000 feet deep). Casing often into bedrock (1980s and later)

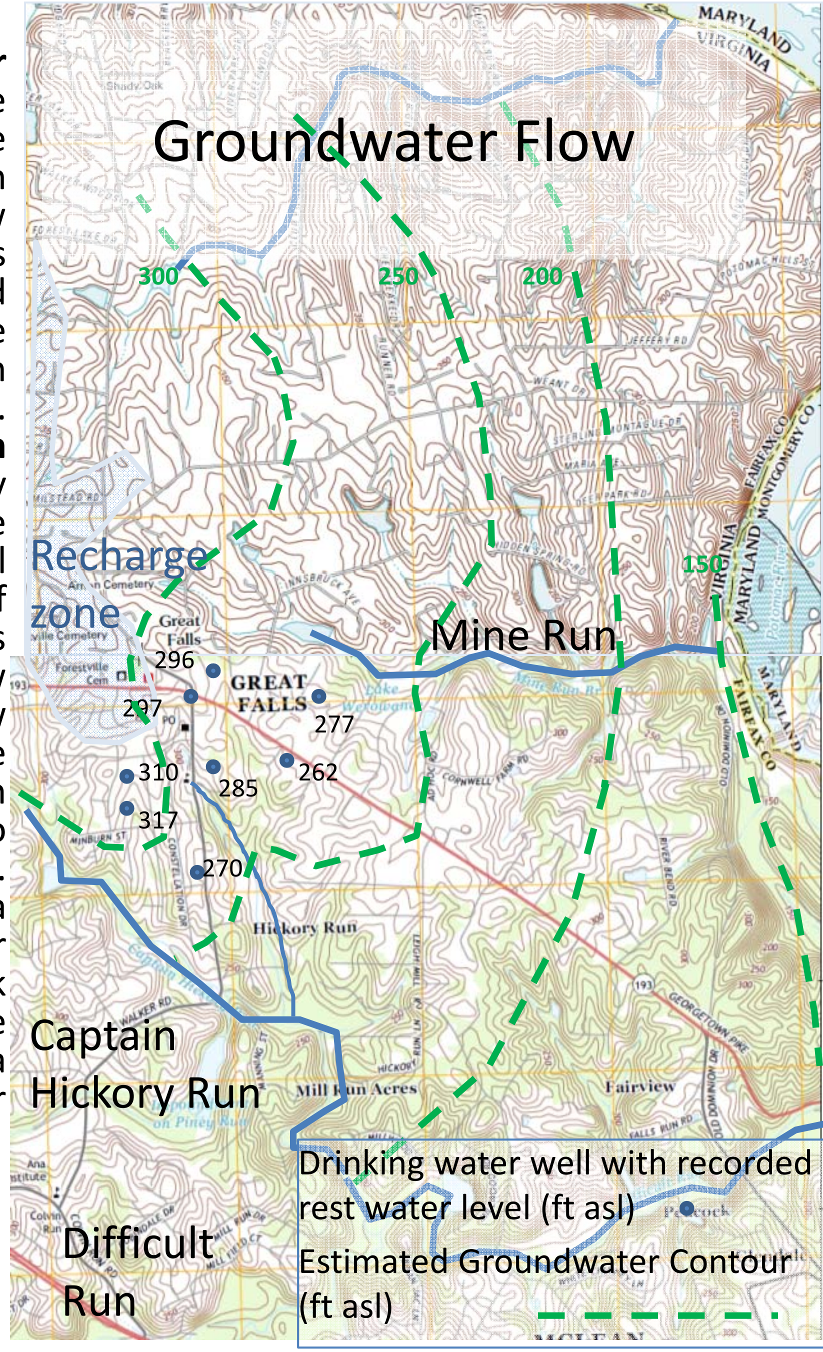


Well construction from available well records



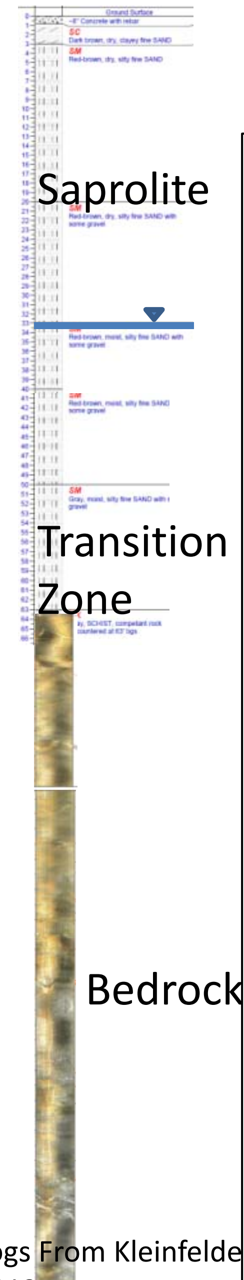
Well construction from available well records

Shallow groundwater flow in the saprolite typically mimics surface topography. Beneath the Site, shallow groundwater flow is likely to be north and northeast toward Mine Run and to the south east toward Hickory Run. **Groundwater flow in bedrock** is strongly influenced by fracture orientation, so local (within a few 100 feet of the Site) flow directions may not match shallow groundwater flow directions. Beneath the Site, groundwater flow in bedrock may occur to the north and southeast. However, over the area as a whole, groundwater flow direction in bedrock will typically be consistent with the area "shallow" groundwater flow direction.



Groundwater beneath the site, whether it is within the shallow saprolite or bedrock, is recharged in higher ground to the north west of the Site. Eventually, all groundwater flows downgradient in a generally easterly and south easterly direction toward Difficult Run and the Potomac River.

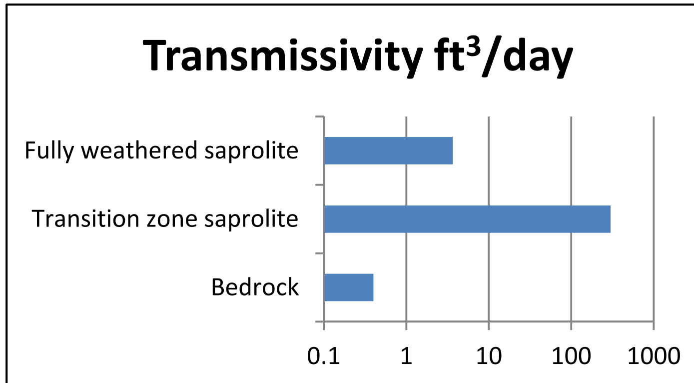
Hydraulic and contaminant transport

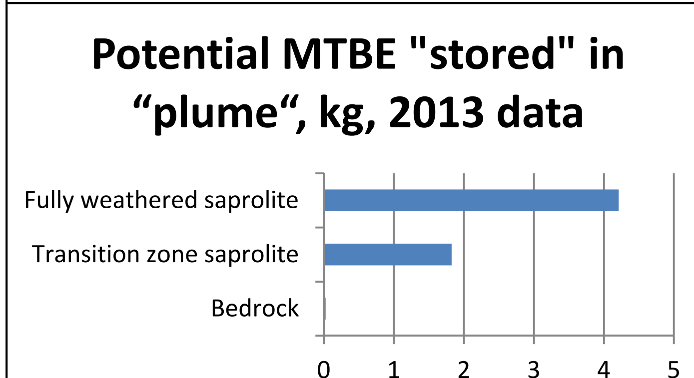


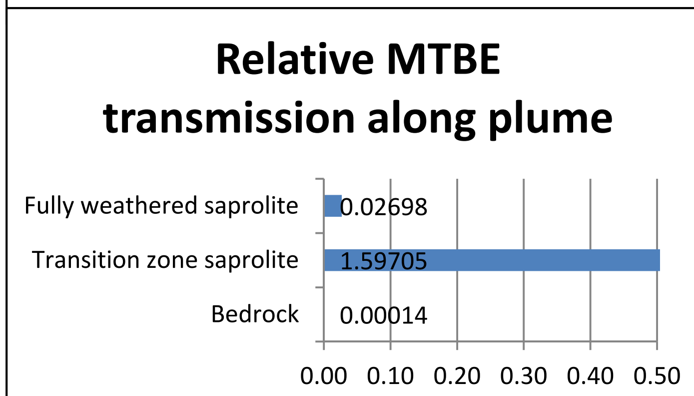
Logs From Kleinfelder 2013

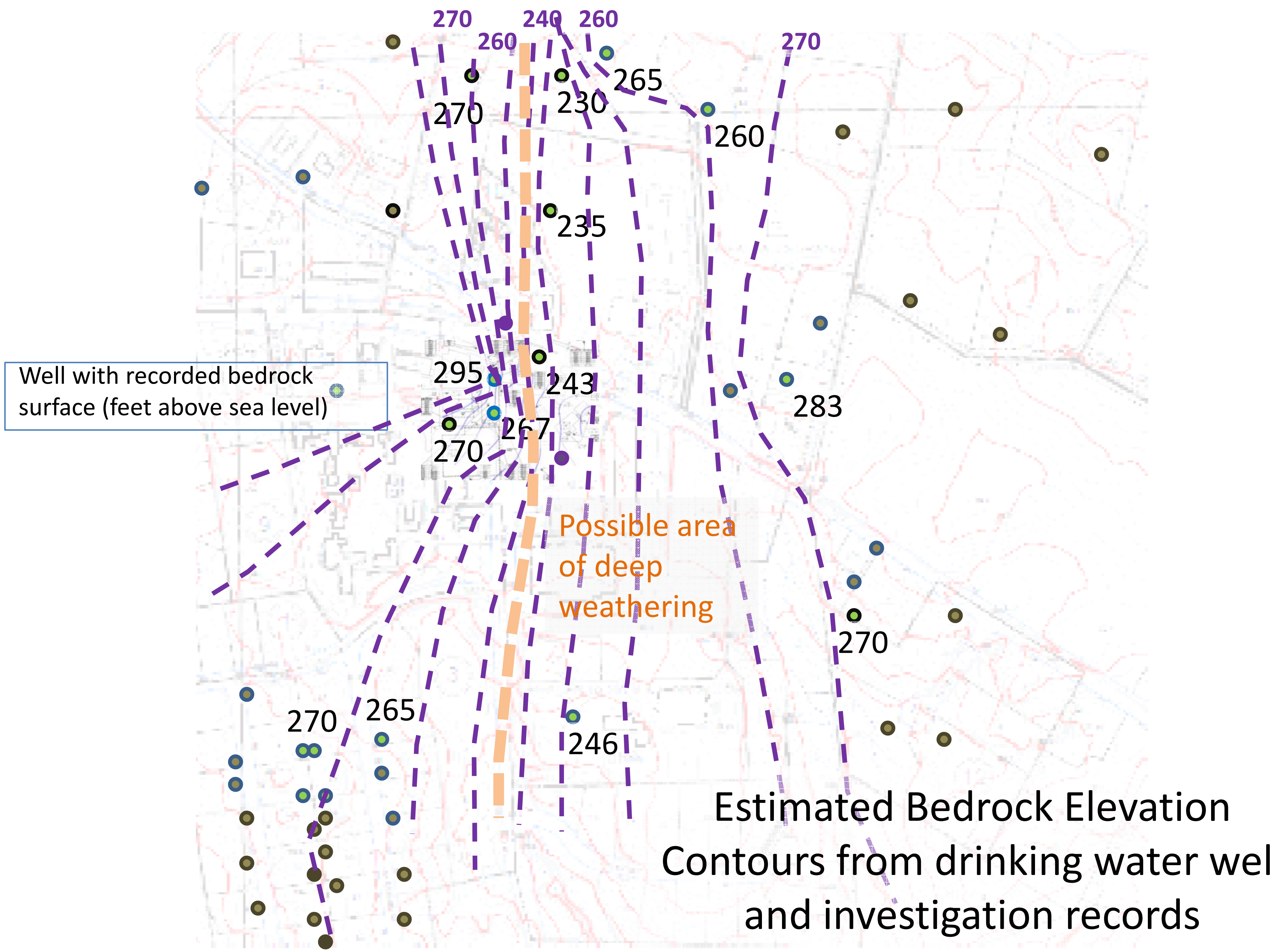
Groundwater is in three “zones” that grade into each other: the saprolite, the “transition zone,” and the unweathered bedrock.

Groundwater is hydraulically connected between these zones over the general area but can be locally separated depending on the nature of the weathering (how much clay) and the local interconnection of fractures in the bedrock and transition zone. In general, the saprolite, having the highest porosity, provides the maximum amount of water storage while bedrock, with water storage only occurring in a small number of open fractures, the least. The transition zone provides the greatest ability to transmit water, and it is this zone that most Great Falls wells tap for water supplies: many deeper wells exist, but in most cases the increased well depth into bedrock provides a reservoir for water storage, rather than providing access to significant water bearing fractures. While groundwater storage in the bedrock may be relatively low, groundwater movement in the fractures in bedrock can be faster than indicated by hydraulic conductivity.





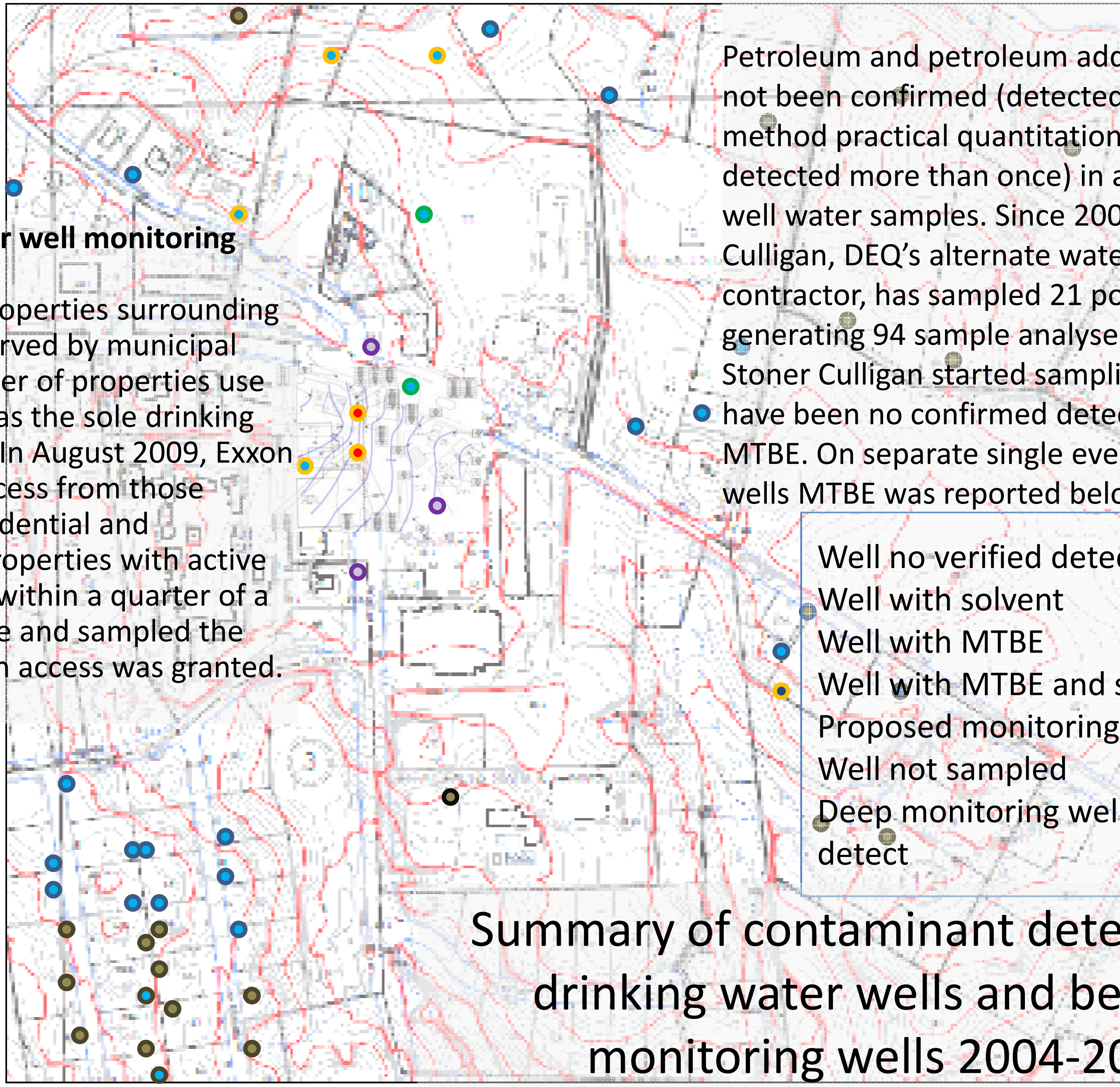



270
260
240
260
270
270
230
265
260
235
Well with recorded bedrock surface (feet above sea level)
295
243
283
267
270
Possible area of deep weathering
270
270
265
246
Estimated Bedrock Elevation Contours from drinking water well and investigation records

Summary of contaminant detections in drinking water wells and bedrock monitoring wells 2004-2013

Drinking water well monitoring

While most properties surrounding the Site are served by municipal water, a number of properties use potable wells as the sole drinking water source. In August 2009, Exxon sought site access from those owners of residential and commercial properties with active potable wells within a quarter of a mile of the Site and sampled the wells for which access was granted.

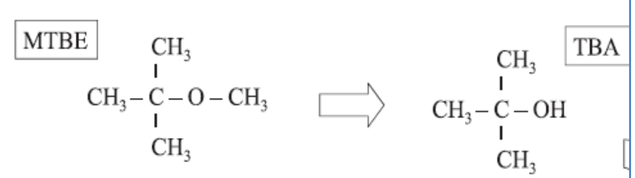


Petroleum and petroleum additives have not been confirmed (detected above the method practical quantitation limit or detected more than once) in any potable well water samples. Since 2009 Stoner Culligan, DEQ's alternate water supply contractor, has sampled 21 potable wells generating 94 sample analyses. Since Stoner Culligan started sampling, there have been no confirmed detections of MTBE. On separate single events at two wells MTBE was reported below the PQL.

MTBE: methyl tertiary butyl ether

MTBE has been recognized as a contaminant of concern in petroleum releases since it was used to replace lead additives as an octane enhancer in gasoline. In the 1990s, MTBE contents in fuel were increased significantly to act as an oxygenate to improve the emission characteristics of gasoline engines. In 2006, most fuel suppliers phased out MTBE "*During debate of the federal Energy Bill in 2005, oil suppliers sought liability immunity for MTBE use. That so-called "safe harbor" provision was rejected by Congress. With no liability protection on MTBE, suppliers requested that the major pipelines remove the MTBE from RFG as soon as possible*[1]."

Early studies suggested MTBE was highly stable in the environment, but work by the US EPA (Wilson et al from 2000 to 2007) show MTBE degrades in groundwater, albeit at rates that are significantly slower than for conventional gasoline (nominal half life of 2 years for MTBE compared to 0.6 years for benzene *EPA OGWDW 2008*).



From EPA 2005

MTBE degrades to TBA, which readily degrades to organic acids, alcohols, acetone and then rapidly to carbon dioxide and water. At the former Exxon, TBA has been detected at concentrations between 10% and 20% of MTBE on site, providing a line of evidence that natural degradation is occurring

Reference numbers for drinking water:
Virginia Department of Health: 20 ug/l
EPA drinking water advisory based on taste and odor: 20 to 40 ug/l
California: 12 ug/l
Virginia Department of Environmental Quality voluntary remediation program screening level: 12 ug/l

1- VPCGA press release 2/14/2006

DEQ’s Petroleum Program approach to Corrective Action objectives

DEQ’s petroleum program is risk based.

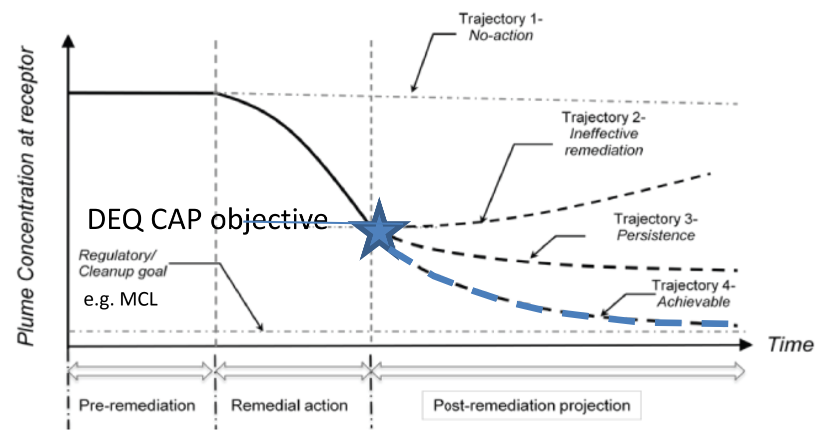
Human or environmental receptors must be at significant risk of being affected.

The remedial objective for concentrations of petroleum in a private drinking water well is Non-Detect.

The remedial objective for concentrations of petroleum near private drinking water wells is a concentration that means the private drinking water well will remain at Non Detect.

The overall objective for a petroleum Corrective Action Plan (CAP) is to reduce concentrations on and off-site to a level that is safe and allows natural attenuation.

Virginia DEQ and US EPA experience show that petroleum, including MTBE, degrades and that natural attenuation occurs with or without active remediation.



From Figure 1.2 Schematic of possible post-remediation trajectories for plume behavior; National Academy of Sciences Alternative for Managing the Nations Complex Contaminated groundwater sites 2013

The remedial objective adopted needs to be protective of human health and the environment and to ensure the contaminant trajectory after active remediation follows “Trajectory 4”